

# Turonian and Coniacian microbiostratigraphy of the Tethys regions on the basis of foraminifera and nannofossils

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With 1 table and 3 plates

## ABSTRACT

The lowermost Turonian is still reached by the Upper Cenomanian *Rotalipora cushmani* Zone in which from the nannoplankton *Quadrum gartneri* PRINS & PERCH-NIELSEN is found.

The higher part of the Lower Turonian (= *Quadrum gartneri* Zone) is always represented by the zone of "large hedbergels" with *Whiteinella gigantea* (LEHMANN) (= syn.: *W. archaeocretacea* PESSAGNO) and *Dicarinella imbricata* (MORNOD) in the Tunisian Atlas. In the West Carpathians *D. imbricata* is found but *Whiteinella gigantea* as well as the association of other "large hedbergels" is missing.

The *Helvetoglobotruncana helvetica* Zone is represented by 3 subzones: *Dicarinella trigona*, *D. biconvexa* and "*Globotruncana*" *turona*. As to nannoplankton of the West Carpathians, we observe here some deviations from Tunisian, typical Mediterranean associations. In the Upper Turonian

*Marginotruncana schneegansi* Zone from its base the index species *Marthasterites furcatus* (STOVER & PERCH-NIELSEN) is found from nannoplankton.

The base of the Coniacian is established by appearance of the species *D. concavata* in both the studied regions whereas the upper boundary is determined by appearance of the species *Sigalia carpathica* SALAJ & SAMUEL. From nannoplankton the associations of the *Marthasterites furcatus* and *Micula decussata* Zone are found in the Coniacian.

Attention is also paid to taxonomic and phylogenetic problems of some foraminifer species. Species of the genus *Dicarinella* described from the West Carpathians are figured again. As the type-species of the genus *Whiteinella* the species ?*Praeglobotruncana gigantea* LEHMANN and of for the one-keeled Middle Turonian "globotruncanes" the new genus *Caronita* is established.

## KURZFASSUNG

Die obercenomane *Rotalipora cushmani* Zone reicht bis in das unterste Turon, wo sie beim Nannoplankton durch das Auftreten von *Quadrum gartneri* PRINS & PERCH-NIELSEN gekennzeichnet wird. Der höhere Teil des Unter-Turon (= *Quadrum gartneri*-Zone) ist in Tunesien immer durch eine Zone „großwüchsiger Hedbergellen mit *Whiteinella gigantea* (LEHMANN) (= *W. archaeocretacea* PESSAGNO) und *Dicarinella imbricata* (MORNOD) gekennzeichnet. In den West-Karpaten tritt zwar *D. imbricata* auf, es fehlen dagegen *W. gigantea* und die anderen großwüchsigen Hedbergellen.

Die *Helvetoglobotruncana helvetica* Zone wird durch drei Subzonen repräsentiert: *Dicarinella trigona*, *D. biconvexa* und "*Globotruncana*" *turona* Subzonen. Das Nannoplankton der West-Karpaten unterscheidet sich leicht von den ty-

pisch mediterranen Vergesellschaftungen Tunesiens. In der oberturonen *Marginotruncana schneegansi* Zone ist die Index-Art *Marthasterites furcatus* (STOVER & PERCH-NIELSEN) bereits ab der Basis vertreten.

Die Basis des Coniac wird in beiden Gebieten durch das Einsetzen von *D. concavata* gekennzeichnet, die obere Grenze durch das Auftreten von *Sigalia carpathica* SALAJ & SAMUEL. Beim Nannoplankton werden im Coniac Vergesellschaftungen der *Marthasterites furcatus* und der *Micula decussata* Zonen gefunden.

Abschließend werden taxonomische und phylogenetische Fragen einiger Foraminiferen-Arten diskutiert. Die bislang aus den West-Karpaten beschriebenen Arten von *Dicarinella* werden neu abgebildet. *Praeglobotruncana* (?) *gigantea* LEHMANN wird als Typus-Art der Gattung *Whiteinella* bestimmt. Für die einkieligen Globotruncanen des Mittel-Turons wird die neue Gattung *Caronita* vorgeschlagen.

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## INTRODUCTION

The basis for detailed stratigraphical division of Turonian-Coniacian sediments in the Mediterranean region on the basis of foraminifers and nannoplankton are some selected profiles of Tunisia and the West Carpathians of Czechoslovakia. In Tunisia it is mainly the profile of hypostratotypes of the mentioned stages from the locality Dj. Fguira Salah (SALAJ 1974, 1980; GAŠPARIKOVÁ 1978) and from the West Carpathians the Turonian of the Klippen Belt from the profiles Vranie–Považský Chlmec, Brodno–Snežnica and Beňatina. For

their completeness these profiles were studied by several authors (SCHEIBNEROVÁ 1960, 1963; SAMUEL 1962; SAMUEL & SALAJ 1962; BEGAN, HAŠKO, SALAJ & SAMUEL 1978). The Coniacian sediments in the facies of variegated marls of the Klippen Belt are studied from the locality Horné Srnie; and in flysch facies from the area of Považská Bystrica. Their Coniacian age was proved on the basis of foraminifers by KANTOROVÁ & BEGAN (1958) and SALAJ (1962). The nannoplankton from these localities was studied by GAŠPARIKOVÁ (1977).

## STRATIGRAPHY

Cenomanian-Turonian boundary: the boundary between the *Rotalipora cushmani* Zone and *Dicarinella imbricata* Zone in the West Carpathians on the one hand, or between the *R. cushmani* Zone and the zone of large *Hedbergella* de LEHMANN (1962) (= *Whiteinella archaeocretacea* Zone de ROBASYNSKI & CARON 1979) in Tunisia on the other hand, is very sharp. The authors place this boundary above the Turonian base, what would be in agreement with the knowledge of BELLIER (1978) and other authors (SALAJ & SAMUEL 1966, 1977; SALAJ & BELLIER 1978). On the contrary, in the last time ROBASYNSKI & CARON (1979) (European working group on plank-

tonic Foraminifera) place the boundary between these zones still in the frame of the uppermost Cenomanian, in the middle of the *Metoicoceras geslinianum* Zone. According to them the species *Rotalipora cushmani* (MORROW) becomes extinct here, and the species *Whiteinella archaeocretacea* PESSAGNO, the index species of the zone of equal name, sets in. On the contrary, the works of CONARD (1978: 66–67), DELOFFRE (1978: 80) and PORTHULT (1978: 184) mention the existence of *Rotalipora* in the basal Turonian, thus in the *Mammites nodosoides* Zone with *Fagesia superstes* (KOSSMAT) (PHILIP, NEUMANN, PORTHULT & JUIGNET 1978).

Table 1

Microbiostratigraphic zonation of the Turonian and Coniacian of the basis of planktonic foraminifers and nannoplankton

AGE AREA	TUNISIA	WEST CARPATHIANS	TUNISIA
CONIACIAN UPPER	<i>Dicarinella concavata</i> IZ	<i>Sigalia deflaensis</i> IZ	<i>Micula decussata</i> IZ
		<i>Globotruncana praehavannensis</i> n sp IZ	<i>Micula decussata</i> IZ
		<i>Helvetoglobotruncana cachensis</i> <i>Globotruncana angusticarinata</i> IZ	<i>Marthasterites furcatus</i> IZ
CONIACIAN LOWER	<i>Dicarinella concavata</i> IZ	<i>Marthasterites furcatus</i> IZ	<i>Marthasterites furcatus</i> IZ
		<i>Eiffelithus eximius</i> IZ	<i>Eiffelithus eximius</i> IZ
TURONIAN UPPER	<i>Marginotruncana schneegansi</i> IZ	<i>Dicarinella renzi</i> IZ	<i>Eiffelithus eximius</i> IZ
		<i>Whiteinella inornata</i> <i>Falsotruncana maslakvae</i> IZ	<i>Eiffelithus eximius</i> IZ
	<i>Helvetoglobotruncana helvetica</i> TRZ	<i>Caranita turana</i> ISBZ <i>Dicarinella biconvexa</i> ISBZ <i>Dicarinella trigona</i> ISBZ	<i>Tetralithus pyramidus</i> IZ
TURONIAN LOWER	<i>Whiteinella gigantea</i> <i>Dicarinella imbricata</i> IZ	<i>Dicarinella hagni</i> ISBZ <i>D. imbricata</i> ISBZ	<i>Tetralithus pyramidus</i> IZ
		<i>Gartnerago obliquum</i> IZ	<i>Quadrum gartneri</i> IZ
CENOMANIAN MIDDLE	<i>Rotalipora cushmani</i> TRZ	<i>Rotalipora turonica</i> TRZ	<i>Micrarhabdulus decoratus</i> IZ
		<i>Rotalipora mansalvensis</i> TRZ	<i>Micrarhabdulus decoratus</i> IZ

We tend to the opinion that the upper boundary of the *Rotalipora turonica* Zone or the *Rotalipora cushmani* Zone (both index species of these zones are distinctly different from each other, cf. SALAJ & SAMUEL 1966) should not be placed into the uppermost Cenomanian, but into the basal Turonian. A compromising solution would be that the boundaries of these zones would also determine the Cenomanian–Turonian boundary (DOUGLAS 1969).

We stress that in Tunisia as well as in the West Carpathians also in the uppermost part of the *Rotalipora cushmani* Zone up to the immediate contact with the following zone representatives of the genus *Rotalipora* are found in extraordinary amounts. Species like *Whiteinella archaocretacea* or *W. paradubia* (SIGAL) are not found here.

From the nannoplankton in the Upper Cenomanian of the West Carpathians *Gartnerago obliquum* (STRADNER) NOEL is found, the index species of the zone of the same name defined by VERBEEK (1976) for the upper part of the *Rotalipora cushmani* Zone reaches the *Helvetoglobotruncana helvetica* Zone in the Turonian of the West Carpathians (Tab. 1).

In the assemblage of the *Gartnerago obliquum* Zone the following nannoplankton species are found: *Corolithion achylosum* (STOVER) THIERSTEIN, *Cyclagelosphaera margereli* NOËL, *Cretarhabdus conicus* BRAMLETTE & MARTINI, *Cretarhabdus crenulatus* BRAMLETTE & MARTINI, *Cretarhabdus unicornis* STOVER, *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT, *Lithraphidites alatus* THIERSTEIN, *Lithraphidites carniolensis* DEFLANDRE, *Lithraphidites floralis* STRADNER, *Manivittella gromosa* BLACK, *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Watznaueria barnesae* (BLACK) PERCH-NIELSEN, *Zycolithus crux* NOEL and *Zycolithus diplogrammus* (BUKRY) NOËL.

The *Rotalipora cushmani* Zone of the Mediterranean region and thus also of Tunisia is characterized by the species *Microrhabdulus decoratus*, which according to THIERSTEIN (1976) is indicative of the Middle to Upper Cenomanian. This species was designated by SISSINGH (1977) and MANIVIT et al. (1977) as index species for the zone of the same name, which is related to the Upper Cenomanian.

Turonian: The lower part of the Lower Turonian (besides the base) is represented in the West Carpathians by the *Dicarinella imbricata* Zone (SALAJ & SAMUEL 1966, 1967; SALAJ & GAŠPARIKOVÁ 1979). In Tunisia the *Rotundina cretacea* – *Praeglobotruncana imbricata* Zone corresponds to it (SALAJ 1969; MASSIN & SALAJ 1970); MAAMOURI & MAAMOURI 1969; SALAJ & BELLIER 1978).

ROBASZYNSKI & CARON (1979) correctly call attention to the fact that the genus *Rotundina* is invalid and that the genus *Whiteinella* PESSAGNO 1969 should be used. Moreover, the opinion of ROBASYNSKI & CARON (1979) is justified that the species *Whiteinella cretacea* (D'ORBIGNY) is found as late as from the Upper Turonian. It is logical to use for the Lower Turonian as index species *Whiteinella archaocretacea* PESSAGNO, in the synonymy of which the species ? *Praeglobotruncana gigantea* LEHMANN (1962) and *Praeglobotruncana lehmanni* PORTHULT (1969) are included.

Regarding to the fact that the species *Praeglobotruncana* (described as *Globotruncana*) *biconvexa gigantea* (SAMUEL & SALAJ) belongs to the genus *Dicarinella* PORTHULT (DONZE et

al. 1970), we cannot consider the species ? *Praeglobotruncana gigantea* LEHMANN, whether in this taxonomic form or as *Whiteinella gigantea*, as a secondary homonym. Therefore in the sense of the International Code of Zoological Nomenclature we call attention to the validity of *Whiteinella gigantea* (LEHMANN) which becomes so also the type species of the genus *Whiteinella* PESSAGNO (1967). The species *Whiteinella archaocretacea* PESSAGNO (1967) is thus a synonym of the species *Whiteinella gigantea* (LEHMANN).

Therefore we modify the Lower Turonian in Tunisia as the *Whiteinella gigantea* – *Dicarinella imbricata* Zone. Its Lower boundary is determined by disappearance of rotalipores while its upper boundary is determined by appearance of the species *Helvetoglobotruncana helvetica* (BOLLI).

In the Lower Turonian of the West Carpathians as well as Tunisia we can define two subzones:

a) *Dicarinella imbricata* Interval Subzone. Its lower boundary is determined by vanishing of rotalipores and conical praeglobotruncanes and the upper boundary by appearance of the species *Dicarinella hagni* (SCHEIBNEROVA).

b) *Dicarinella hagni* Interval Subzone. Its lower boundary is defined by appearance of the species *Dicarinella hagni* (SCHEIBNEROVA), while the upper boundary is determined by appearance of the species *Helvetoglobotruncana helvetica* (BOLLI).

Besides the species *Dicarinella hagni*, which is very abundant here, *Dicarinella turonica* (SAMUEL & SALAJ) appears, representing a form transitional between *Dicarinella hagni* und *Dicarinella trigona* (SCHEIBNEROVA). Even it would seem that these last quoted 3 species described from the West Carpathians are boreal elements, we remark that they are uncommonly abundant also in Tunisia, studied in detail mainly in the area of Enfidaville (SALAJ 1970).

In the Lower Turonian nannoplankton of Tunisia, it is necessary to quote mainly the occurrence of the species *Quadrum gartneri* PRINS & PERCH-NIELSEN. PERCH-NIELSEN (1979) mentioned, this species appears from the Turonian base. SISSINGH (1977) defined a zone of equal name, which reaches the middle part of the Middle Turonian *Helvetoglobotruncana helvetica* Zone of SIGAL (1952).

The late Lower Turonian to base of the Upper Turonian – in Tunisia as well as the West Carpathians – corresponds with three subzones (SALAJ & SAMUEL 1966, SALAJ & BELLIER 1978; BEGAN, HASKO, SAMUEL & SALAJ 1978; SALAJ & GAŠPARIKOVÁ 1979) to the *Helvetoglobotruncana helvetica* Total-range Zone:

a) *Dicarinella trigona* Interval Subzone: Its lower and upper boundaries are limited by appearance of *Helvetoglobotruncana helvetica* (BOLLI) and *Dicarinella biconvexa* (SAMUEL & SALAJ). Beside the index species and some representatives of the genus *Whiteinella*, *Dicarinella imbricata*, and *D. hagni* are still represented.

b) *Dicarinella biconvexa* Interval Subzone: Its boundaries are limited by appearance of the species *Dicarinella biconvexa* at the base and by the species *Caronita turona* (OLBERTZ) on the top.

c) *Caronita turona* Interval Subzone: It is defined by appearance of the species *Caronita turona* at the base. The up-



per boundary is determined by disappearance of the species *Helvetoglobotruncana helvetica* (BOLLI).

The subdivision of the lower Middle Turonian is based on the lineage of the following species (BEGAN, HAŠKO, SALAJ & SAMUEL 1978):

- a) *Dicarinella imbricata* → *D. turonica* → *D. trigona*
- b) *Dicarinella imbricata* → *D. bagni* → *D. biconvexa* →  
*Dicarinella fusani* SALAJ & SAMUEL (1977) →  
b<sub>1</sub> → *Caronita sigali*  
b<sub>2</sub> → *Caronita turona*

From the taxonomic point of view it is necessary to mention that neither *Dicarinella trigona* (SCHEIBNEROVA) nor *Dicarinella oraviensis* (SCHEIBNEROVA) can be a synonym of the species *Praeglobotruncana gibba* KLAUS (ROBASZYNSKI & CARON 1979). *Praeglobotruncana gibba* KLAUS is described from the Cenomanian, essentially smaller in dimensions and distinctly different in morphology of the last chamber. The species *Praeglobotruncana gibba*, mentioned as morphotype by ROBASYNSKI & CARON (1979) from the Middle Turonian of Tunisia (E 16) corresponds to the typical species *Dicarinella trigona* described from the area of Enfidaville, Djebel Abid (SALAJ 1970).

A further not less important problem is the taxonomic position of Middle Turonian one-keeled representatives, either assigned to the genus *Globotruncana* CUSHMANN (1927) or to the genus *Marginotruncana* HOFKER (1956).

The type species of the genus *Marginotruncana*, *M. marginata* (REUSS) is derived from *Whiteinella* (= *Rotundina*) *cretacea* (D'ORBIGNY) (1972). On the contrary, the representatives of globotruncanids in the Middle Turonian, as pointed out by & (1977), are derived from the genus *Dicarinella* (= *Praeglobotruncana*) PORTHULT (in: DONZE et al., 1979). On the basis of the mentioned we introduce for them the new genus *Caronita*.

*Caronita* nov. gen. (name established in honour of Prof. Dr. Michèle CARON, Fribourg); as type species we designate the type specimen of *Globotruncana sigali* REICHEL (1950).

The diagnostic description of the genus agrees with the original description of the species *Globotruncana sigali* REICHEL, completed by ROBASYNSKI & CARON (1979: 141).

The genus *Caronita* n. gen. has thus diagnostic marks very close to the genus *Marginotruncana* HOFKER (1956) (see ROBASYNSKI & CARON 1979:97), from which *Caronita* differs in the presence of one keel and in its phylogenetic origin. We assign here the following species: *Caronita marianosi* (DOUGLAS), *Caronita sigali* (REICHEL), *Caronita turona* (OLBERTZ).

In the Tunisian Middle Turonian nannoplankton the index species *Tetralithus pyramidus* appears from the base of the *Dicarinella trigona* Subzone, while in the West Carpathians it appears much later only in the upper part of the *D. trigona* Subzone. In Tunisia we thus relate the *Tetralithus pyramidus* Zone with the lower part of the *D. trigona* Subzone, while in the West Carpathians it represents the upper part of the *D. trigona* Subzone, the *Dicarinella biconvexa* Subzone and the lower part of the *Caronita turona* Subzone.

The nannoplankton assemblages of this zone are represented by the following species: *Abmuellerella octoradiata* (GORKA) REINHARDT, *Biscutum constans* PERCH-NIELSEN, *Co-*

*rolithion exiguum* STRADNER, *Cretarhabdus conicus* BRAMLETTE & MARTINI, *Cretarhabdus crenulatus* BRAMLETTE & MARTINI, *Eiffelithus turriseiffeli* (DEFLANDRE) REINHARDT, *Gartnerago obliquum* (STRADNER) NOEL, *Lucianorhabdus cayeuxi* DEFLANDRE, *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER, *Tetralithus pyramidus* (GARDET) *Tranolithus orionatus* (REINHARDT) and *Zygotolithus diplogrammus* (BUKRY) NOEL.

In Tunisia practically the whole *Helvetoglobotruncana helvetica* Zone (except the lower part of the *Dicarinella trigona* Subzone) corresponds to the nannoplankton *Eiffelithus eximius* Interval Zone. Its base is determined by appearance of *Eiffelithus eximius* and the upper boundary by appearance of *Marthasterites furcatus*, which in Tunisia, as we stress, appears immediately above the disappearance of *Helvetoglobotruncana helvetica*.

The *Eiffelithus eximius* Zone is also developed in the Mediterranean region in relation with the Middle Turonian. *E. eximius* is very distinctly accompanied in the assemblages by *Litbastrinus floralis* and *Tranolithus orionatus*.

In both the studied regions the Upper Turonian is characterized by the *Marginotruncana schneegansi* Zone, here considered as Interval Zone in the sense of DALBIEZ (1955). Its foraminifer association was described by several authors (SALAJ & SAMUEL 1966, 1977; BEGAN, HAŠKO, SAMUEL & SALAJ 1978; SALAJ & GAŠPARIKOVÁ 1979).

In the West Carpathians this zone corresponds to the nannoplankton *E. eximius* Zone. Essentially the same species as in the *Tetralithus pyramidus* Zone are found here. For the first time from its base *E. eximius* (STOVER) PERCH-NIELSEN appears. In the *Marginotruncana schneegansi* Zone we distinguish two subzones:

a) The *Whiteinella inornata* – *Falsotruncana maslakovae* Subzone. Its lower boundary is defined by the disappearance of *Helvetoglobotruncana helvetica* and the upper boundary is characterized by the appearance of *Dicarinella renzi* (GANDOLFI) emend. SALAJ & SAMUEL (1966). In this subzone the following species have been found: *Dicarinella carpathica* (SCHEIBNEROVA), *Whiteinella inornata* (BOLLI), *Falsotruncana loeblichae* (DOUGLAS), *F. douglasi* CARON, *F. maslakovae* CARON, *Marginotruncana schneegansi* (SIGAL) emend. SALAJ, *Dicarinella schneegansi* (SIGAL) emend. CARON and *Marginotruncana marginata* (REUSS).

b) *Dicarinella renzi* Subzone. The lower and upper boundary is defined by the appearance of *Dicarinella renzi* (GANDOLFI) emend. SALAJ & SAMUEL (1966) at the base, and appearance of *Dicarinella concavata* (BROTZEN) and *Helvetoglobotruncana cachensis* DOUGLAS at the top. Besides the above mentioned species *Marginotruncana paraconcavata* PORTHULT, *M. undulata* (LEHMANN), *Dicarinella renzi* (GANDOLFI) emend. SALAJ & SAMUEL, *D. condyeriensis* GANDOLFI and *Marginotruncana coronata* (BOLLI) are found.

In Tunisia the *Marginotruncana schneegansi* Zone can be correlated with the nannoplankton *Marthasterites furcatus* Zone. The species *M. furcatus* is found in the profile of Dj. Fguira Salah from the base of the *Marginotruncana schneegansi* Zone (sample no. 133, cf., Fig. 28, in SALAJ 1980: 77).

In the Mediterranean region *M. furcatus* has been mentio-

ned only from the Coniacian base by all authors (THIERSTEIN 1976, SISSINGH 1977, VERBEEK 1977, PERCH-NIELSEN 1979).

The Upper Turonian is thus represented in Tunisia by the nannoplankton *Marthasterites furcatus* Zone, which reaches without any essential changes in composition the Middle Coniacian.

In the association of this zone, thus from its base, the following species are found: *Abmuellerella octoradiata* (GORKA) REINHARDT, *Corollithion exigum* STRADNER, *Corollithion signum* STRADNER, *Cylindralithus serratus* BRAMLETTE & MARTINI, *Eiffelithus eximius* (STOVER), PERCH-NIELSEN, *E. turrisseiffeli* (DEFLANDRE) REINHARDT, *Gartnerago obliquum* (STRADNER) NOEL, *Lithastrinus floralis* STRADNER, *Marthasterites furcatus* (DEFLANDRE) *Lucianorhabdus cayeuxi* DEFLANDRE, *Praediscosphaera cretacea* (ARKHANGELSKIJ) GARTNER), *Tetralithus pyramidus* GARDET, *Tranolithus exiguus* STOVER, *T. orionatus* (REINHARDT) *Watznaeria barnesae* (BLACK) PERCH-NIELSEN, *Zycolithus diplogrammus* (BUKRY) NOEL, *Zycolithus erectus* DEFLANDRE.

Turonian – Coniacian boundary: In Tunisia (SALAJ 1980), similar to the West Carpathians (BEGAN, HAŠKO, SALAJ & SAMUEL 1978; SALAJ & GASPARIKOVA 1979) it is represented by the appearance of *Dicarinella concavata* (BROTZEN), *D. asymetrica* (SIGAL), *Helvetoglobotruncana cachensis* (DOUGLAS) and *Marginotruncana angusticarinata* GANDOLFI.

Coniacian. The basis for subdivision of the Coniacian in the Mediterranean region is mainly the profile proposed for the hypostatotype of the Coniacian (SALAJ 1978). In both the studied regions the Coniacian associations are essentially identical. To the Coniacian as a whole the *Dicarinella concavata* Interval Zone corresponds, the upper boundary of which is characterized by the appearance of *Sigalia carpathica*. We prefer to use this zone instead of the *Marginotruncana* (= *Globotruncana*) *angusticarinata* Zone (defined by SAMUEL & SALAJ, 1968) for the presence of *D. concavata* has been unambiguously proved from the Coniacian base. Besides that, when also in other sense, this zone was defined first by DALBIEZ (1955).

In the Coniacian of both studied regions we define the following subzones:

a) *Helvetoglobotruncana cachensis* – *Marginotruncana angusticarinata* Subzone. It essentially corresponds to the Lower Coniacian. Its upper boundary is defined by appearance

of the new (see below) species *Globotruncanella praehavanensis* n. sp. This zone covers only a part of the nannoplankton *Marthasterites furcatus* Zone (Tab. 1).

To the Middle and partly Upper Coniacian the *Globotruncanella praehavanensis* ISBZ (= Interval Subzone) corresponds. It is characterized at base by the appearance of *Globotruncanella praehavanensis* n. sp. (syn.: *Globotruncanella havanensis* [VORWIJK], in: SALAJ 1980, pl. 12, figs. 4–5). The upper boundary is characterized by the appearance of *Sigalia deflaensis* (SIGAL). This zone corresponds to the older *Globotruncana primitiva* Subzone defined by SALAJ (1970).

Into this zone all above cited species are passing, which appear in the Lower Coniacian. From more important species found here we mention: *Globotruncana desioi* GANDOLFI, *Neoflabellina suturalis suturalis* (CUSHMAN) and *Lenticulina (Marginulinae) gosae* (REUSS). A part of this subzone still corresponds to the nannoplankton *Marthasterites furcatus* Zone.

In Tunisia in the upper part of the *Globotruncanella praehavanensis* Subzone the index species *Micula decussata* appears. In the West Carpathians this species appears later in the uppermost part of the *G. praehavanensis* Subzone, practically closely before *Sigalia deflaensis* appears and passes into the *S. deflaensis* Subzone (Tab. 1).

The uppermost Coniacian is characterized by the *Sigalia deflaensis* Interval Subzone, originally defined by SALAJ & SAMUEL (1966). The lower boundary is characterized by the appearance of *S. deflaensis*, the upper boundary and also the Coniacian – Santonian boundary by that of *Sigalia carpatica* SALAJ & SAMUEL.

In Tunisia this subzone corresponds to the lower part of the nannoplankton *Micula concava* Zone, originally defined by VERBEEK (1977) for the Santonian.

The species *Micula concava* (STRADNER) BUKRY appears from the base of the *S. deflaensis* Subzone. In its association are found: *Eiffelithus eximius* (STOVER) PERCH-NIELSEN, *E. turrisseiffeli* (DEFLANDRE) REINHARDT, *Cylindralithus serratus* BRAMLETTE & MARTINI, *Gartnerago obliquum* (STRADNER) NOEL, *Lithastrinus floralis* STRADNER, *Micula desussata* VEKSHINA, *Lucianorhabdus cayeuxi* DEFLANDRE, *Tetralithus pyramidus* GARDET, *Tranolithus exiguus* STOVER, *Watznaeria barnesae* (BLACK) PERCH-NIELSEN, *Zycolithus diplogrammus* (BUKRY) NOEL and *Zycolithus erectus* DEFLANDRE.

## PALEONTOLOGICAL DESCRIPTION

Genus *Globotruncanella* REISS 1957

*Globotruncanella praehavanensis* n. sp.

Pl. 2, figs. 10, 11, 12, 14, 15, 16

Holotype: figured pl. 2, figs. 10–12 and deposited in the collections of the Dionýz Štúr Institute of Geology, Bratislava.

Derivatio nominis: Derived from the name *havanensis*, for we suppose that this species represents an ancestral form of the species *G. havanensis* (VORWIJK).

Stratum typicum: Coupe de l'Anticlinale Oued Bazina, sample no. Be 53/11 (MAAMOURI & MAAMOURI 1969; SALAJ & MAAMOURI 1971). Upper Coniacian marls from the *Sigalia deflaensis* Subzone.

Material: About 10 specimens from sample Be 53/11; about 100 specimens from the Middle Coniacian sequence of the profile Dj. Fguira Salah near Pont du Fahs – Tunisia (samples no. 1302 a–h; SALAJ 1980, fig. 30); 3 specimens from the Coniacian flysch sequence – road cut 1 km S of Považská Bystrica.



**Diagnosis:** Umbilical side: Primary aperture extraumbilical – umbilical; long portici form around the umbilicus. Sutures radial and depressed; 5, rarely 6 chambers. Chambers inflated to globular; the first to fourth are pustulose, the last is more or less smooth. Umbilicus forming about  $\frac{1}{3}$  of the largest diameter.

**Spiral side:** Equatorial periphery clearly lobulate. Chambers petaloid in shape with surface gently inflated, pustulose, moderately increasing in size. Sutures curved with not distinct keel formed with pustules on all chambers of the last whorl. Spire constituted by  $2\frac{1}{2}$  to 3 well distinct whorls. The chambers of the first whorl are globular.

**Lateral view:** Low trochospire. Equatorial periphery bordered by a distinct flange formed by 1–2 lines of pustules on the 4 chambers. The outline of the last chamber is subglobular to gently subangular.

**Size:** diameter variable, between 0,5 to 0,6 mm.

**Stratigraphic range:** The new species occurs from the higher, probably Middle Coniacian to the Lower Santonian. It forms a distinct horizon in association with: *Dicarinella concavata* (BROTZEN), *D. asymetrica* (SIGAL), *D. primitiva* DALBIEZ, *Marginotruncana angusticarinata* (GANDOLFI), *M. marginata* (REUSS), *M. undulata* (LEHMANN), *M. sinuosa* PORTHULT and *Helvetoglobotruncana cachensis* DOUGLAS.

## CONCLUSIONS

A detailed microbiostratigraphy has been carried out on the basis of planktonic foraminifers and nannoplankton for Turonian-Coniacian sediments of two distant Tethyan regions

(Tunisian Atlas and West Carpathians). In the West Carpathians the index species of Turonian-Coniacian zones appear later than in the Mediterranean region and in Tunisia (Tab. 1).

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Plate 1

- Fig. 1– 2. *Dicarinella imbricata* (MORNOD); 1. lateral view 80×; 2. spiral view 70×.  
Loc.: No. 14/1960 Beňatína. *Dicarinella hagni* Subzone.  
Lower Turonian of the Klippen Belt; Eastern Slovakia.
- Fig. 3– 5. *Dicarinella hagni* (SCHEIBNEROVA); 3. lateral view 90×; 4. lateral view 70×;  
5. lateral view 90×.  
Loc.: No. 14/1960 Beňatína.
- Fig. 6, 8. *Dicarinella hagni* (SCHEIBNEROVA); 6. lateral view 10×; 8. lateral view 70×.  
Loc.: No. 14/1960 Beňatína.
- Fig. 7. *Dicarinella bouldmensis* (PESSAGNO); lateral view 90×.  
Loc.: No. 14/1960 Beňatína.
- Fig. 9–10. *Dicarinella biconvexa* (SAMUEL & SALAJ); 9. spiral view 60×; 10. lateral view of the other  
individual 60×;  
Loc.: No. 8/1960 Beňatína. *Dicarinella biconvexa* Subzone; Middle Turonian of the  
Klippen Belt.
- Fig. 11. *Dicarinella gigantea* (SAMUEL & SALAJ); lateral view 70×.  
Loc.: No. 1960. Beňatína.



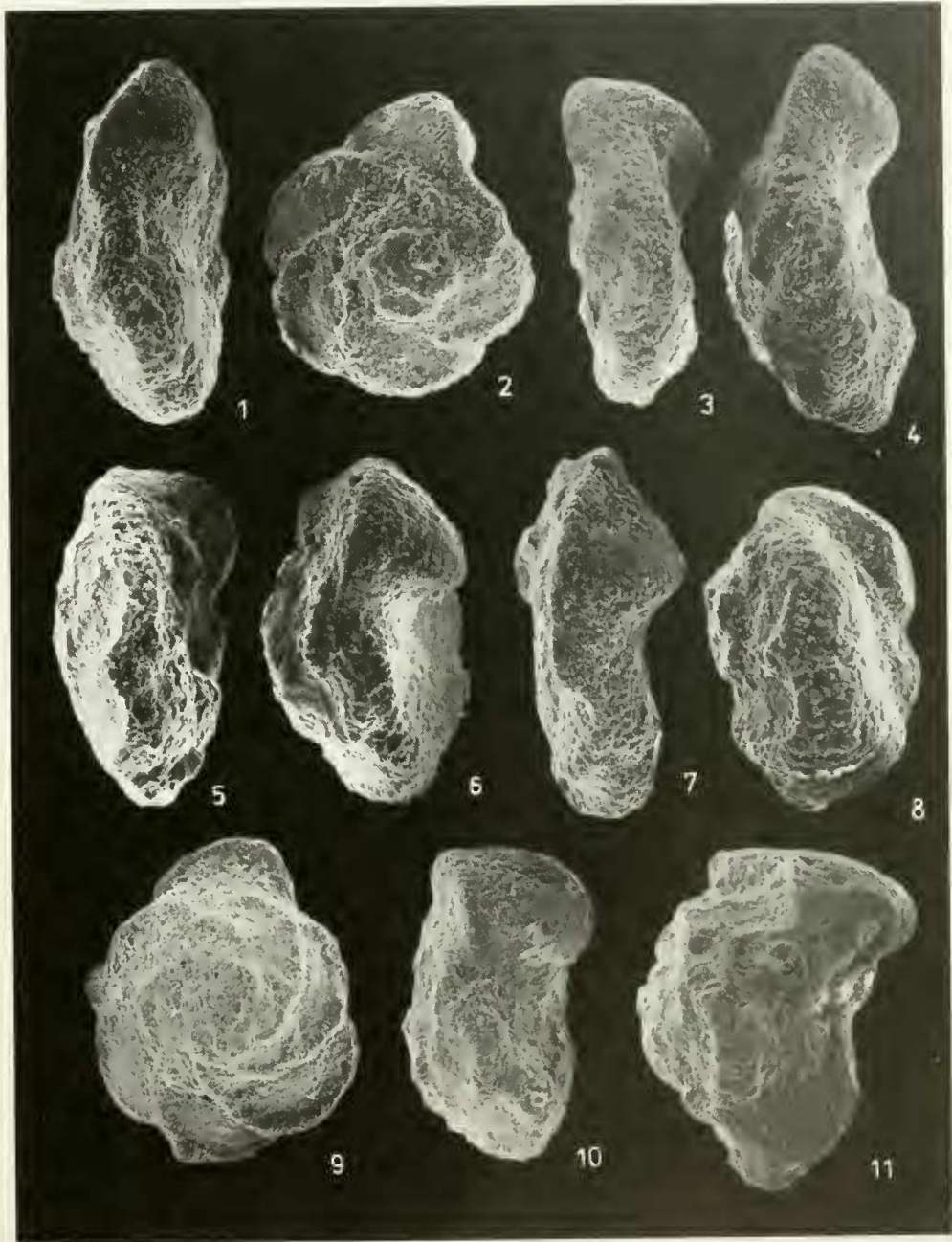


Plate 2

- Fig. 1. Transitional form between *Dicarmella turonica* (SAMUEI & SAI AJ) and *D. trigona* (SCHEIBNEROVA); lateral view 80×.  
Loc.: No. 14/1960 Beňatina, *D. bagii* Subzone; Lower Turonian of the Klippen Belt, Eastern Slovakia.
- Fig. 2-3. *Dicarmella turonica* (SAMUEI & SAI AJ); 2. spiral view 55×; 3. umbilical view 55×.  
Loc.: No. 14/1960, Beňatina.
- Fig. 4-6. *Dicarmella trigona* (SCHEIBNEROVA); 4. spiral view 55×; 5. lateral view 55×; 6. spiral view of the other individual 75×.  
Loc.: No. 5/1960 Beňatina, *D. trigona* Subzone; Middle Turonian of the Klippen Belt.
- Fig. 7-9. *Dicarmella oraviensis* (SCHEIBNEROVA); 7. lateral view 70×; 8. spiral view 70×; 9. umbilical view of the other individual 70×.  
Loc.: No. 5/1960 Beňatina.
- Fig. 10-12. *Globotruncanella prachovanensis* n. sp. holotype;  
10. lateral view 60×; 11. oblique umbilical view 60×; 12. oblique umbilical view 60×.  
Loc.: No. 53/13 Béja (Anticline Oued Bazina, Tunisia); *Sigalia deflaensis* Subzone; Upper Coniacian.
- Fig. 13. *Dicarmella oraviensis* (SCHEIBNEROVA); lateral view 70×;  
Loc.: No. 5/1960 Beňatina, Lower part of the *Helvetoglobotruncana helvetica* Zone.
- Fig. 14-16. *Globotruncanella prachovanensis* n. sp.;  
14. spiral view 60×; 15. oblique umbilical view 60×; 16. umbilical view 60×;  
Loc.: same as figs. 10-12.

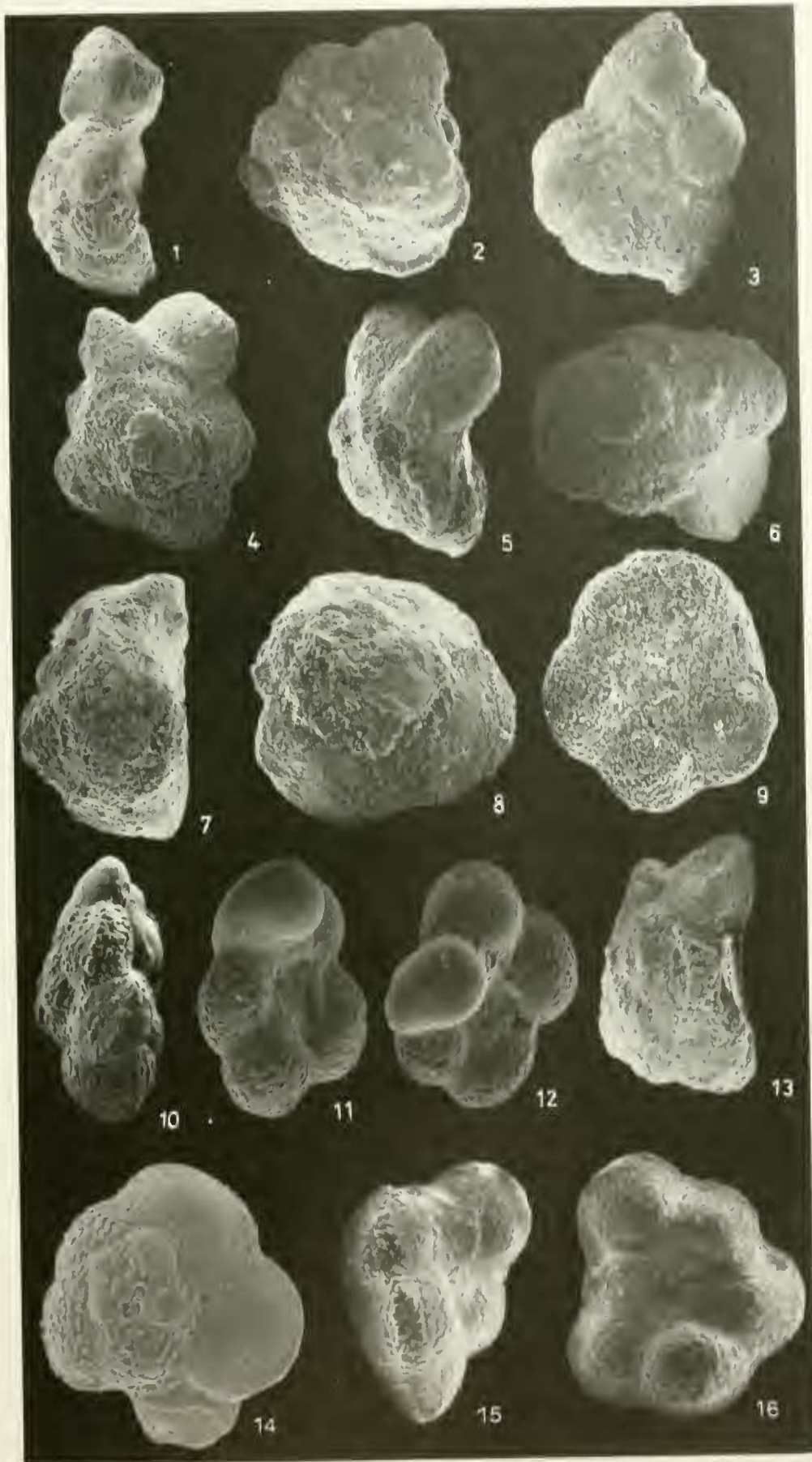


Plate 3

- Fig. 1. *Gartnerago obliquum* (STRADNER) REINHARDT, 5000×, distal view.  
Slopná, Nr. 440/79; Upper Cenomanian.
- Fig. 2. *Lutraphidites acutum* VERBEEK & MANIVIT, 5000×,  
Pont du Fahs, Nr. 662/77; Upper Cenomanian.
- Fig. 3. *Corolithion exiguum* STRADNER, 5000×, distal view.  
Pont du Fahs, Nr. 665/77; Middle Turonian.
- Fig. 4. *Quadrum gartneri* PRINS & PERCH-NIELSEN, 5000×,  
Pont du Fahs, Nr. 664/77; Lower Turonian.
- Fig. 5. *Luthastrinus floralis* STRADNER, 5000×, proximal view.  
Brodno, Nr. 329/76; Middle Turonian.
- Fig. 6. *Abmuellerella octoradiata* (DORKA) REINHARDT, 5000×, proximal view.  
Snežnica, Nr. 500/77; Lower Turonian.
- Fig. 7. *Stephanolithion laffitei* Noël, 5000×, proximal view.  
Vršatec, Nr. 408/77; Lower Coniacian.
- Fig. 8. *Tranolithus oronatus* (REINHARDT) REINHARDT, 5000×, proximal view.  
Vranie, Nr. 526/77; Lower Turonian.
- Fig. 9. *Eiffelithus eximius* (STRADNER) PERCH-NIELSEN, 5000×, distal view.  
Myjavská pahorkatina, Nr. 310/73; Middle Coniacian.
- Fig. 10. *Marthasterites furcatus* DEFLENDRE, 3500×,  
Pont du Fahs, Nr. 667; Upper Turonian.
- Fig. 11. *Marthasterites furcatus* DEFLENDRE, 5000×,  
Pont du Fahs, Nr. 667; Upper Turonian.
- Fig. 12. *Micula decussata* VEKSHINA, 4500×,  
Pont du Fahs, Nr. 636/9; Middle Coniacian.



